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(54) **ULTRAVIOLET IRRADIATION HEAD AND ULTRAVIOLET IRRADIATOR**

(71) Applicant: **Panasonic Industrial Devices SUNX Co., Ltd.**, Kasugai-shi (Aichi-ken) (JP)

(72) Inventors: **Akihiro Tahara**, Kasugai (JP); **Tsuyoshi Inui**, Kasugai (JP); **Noriyuki Taguchi**, Kasugai (JP); **Yoshiyuki Nakazono**, Kasugai (JP); **Kanto Imai**, Kasugai (JP)

(73) Assignee: **Panasonic Industrial Devices SUNX Co., Ltd.**, Aichi-ken (JP)

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H01L 33/64 (2010.01)
H01L 27/15 (2006.01)

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CPC ***H01L 33/645*** (2013.01); ***H01L 27/153*** (2013.01)

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USPC 347/102
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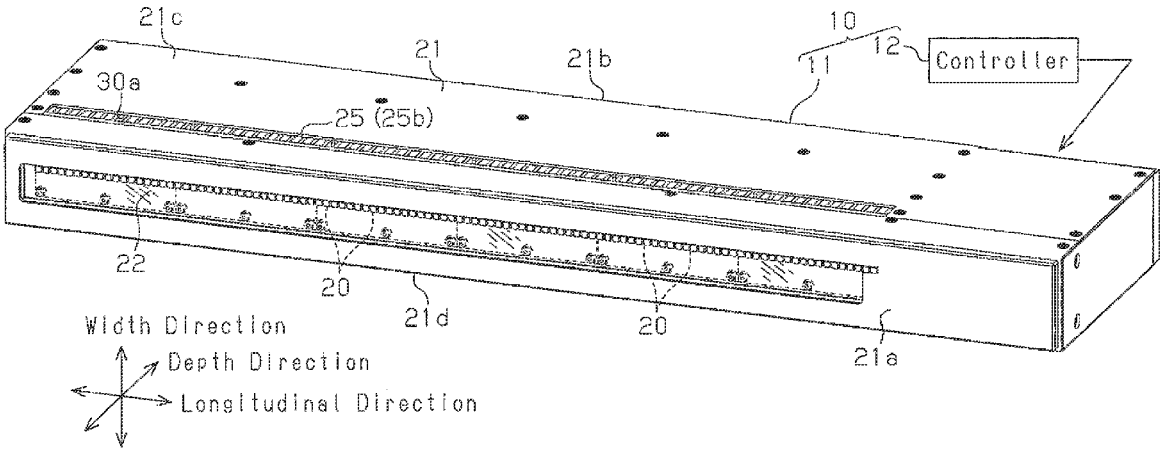
Primary Examiner — Alessandro Amari
Assistant Examiner — Michael Konczal
(74) *Attorney, Agent, or Firm* — Faegre Baker Daniels LLP

(57) **ABSTRACT**

A heat sink is thermally connected to a substrate on which LED elements are mounted. A fan unit is arranged near the distal end of a fin segment of the heat sink. A vent hole is formed in a case so as to expose the base end of the fin segment entirely in a direction in which fins are aligned. The heat sink is configured such that a gap between the fins is substantially blocked in a part except where the vent hole is present. The gap is an opening extending in a width direction perpendicular to the direction in which the fins are aligned. Space between the distal end of the fin segment and the fan unit functions as a pressure chamber that is placed in a positively pressurized condition or a negatively pressurized condition by cooling air traveling from the fan unit.

3 Claims, 5 Drawing Sheets



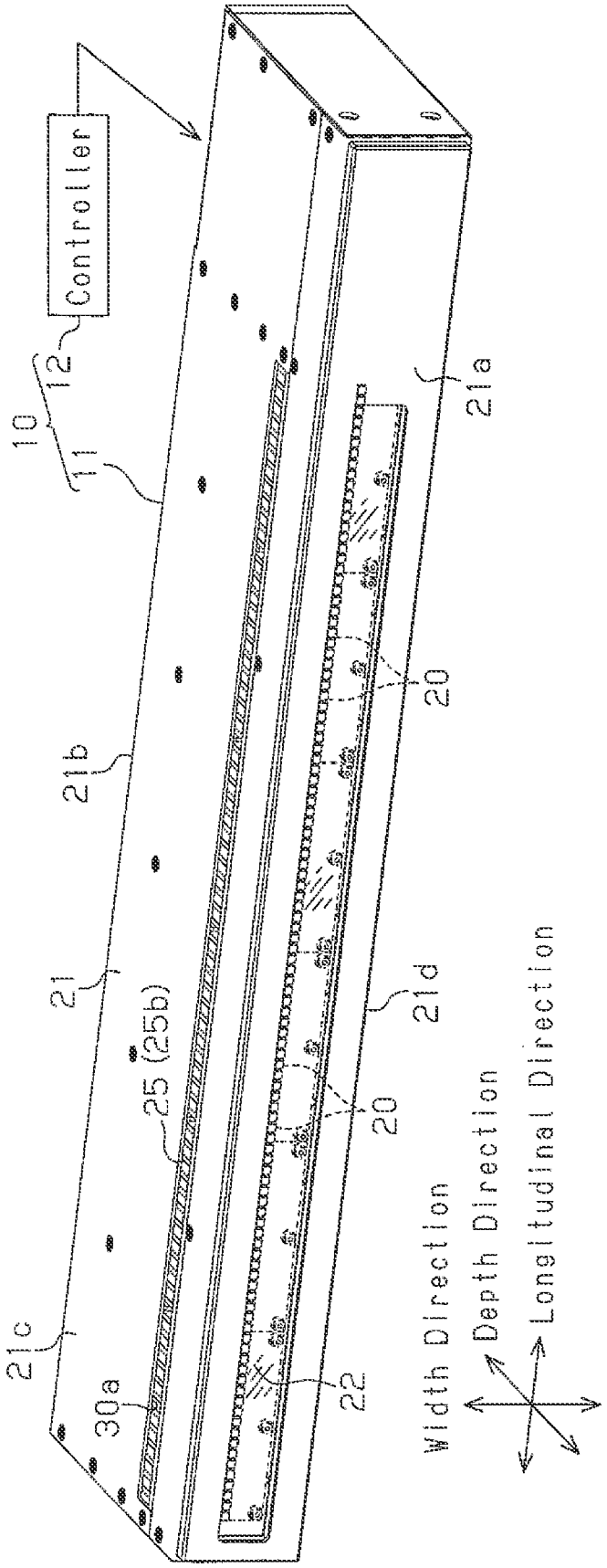

Controller
12
10
11
21a
21b
20
21
25 (25b)
21d
20
21c
30a
22
Width Direction
Depth Direction
Longitudinal Direction

Fig.1

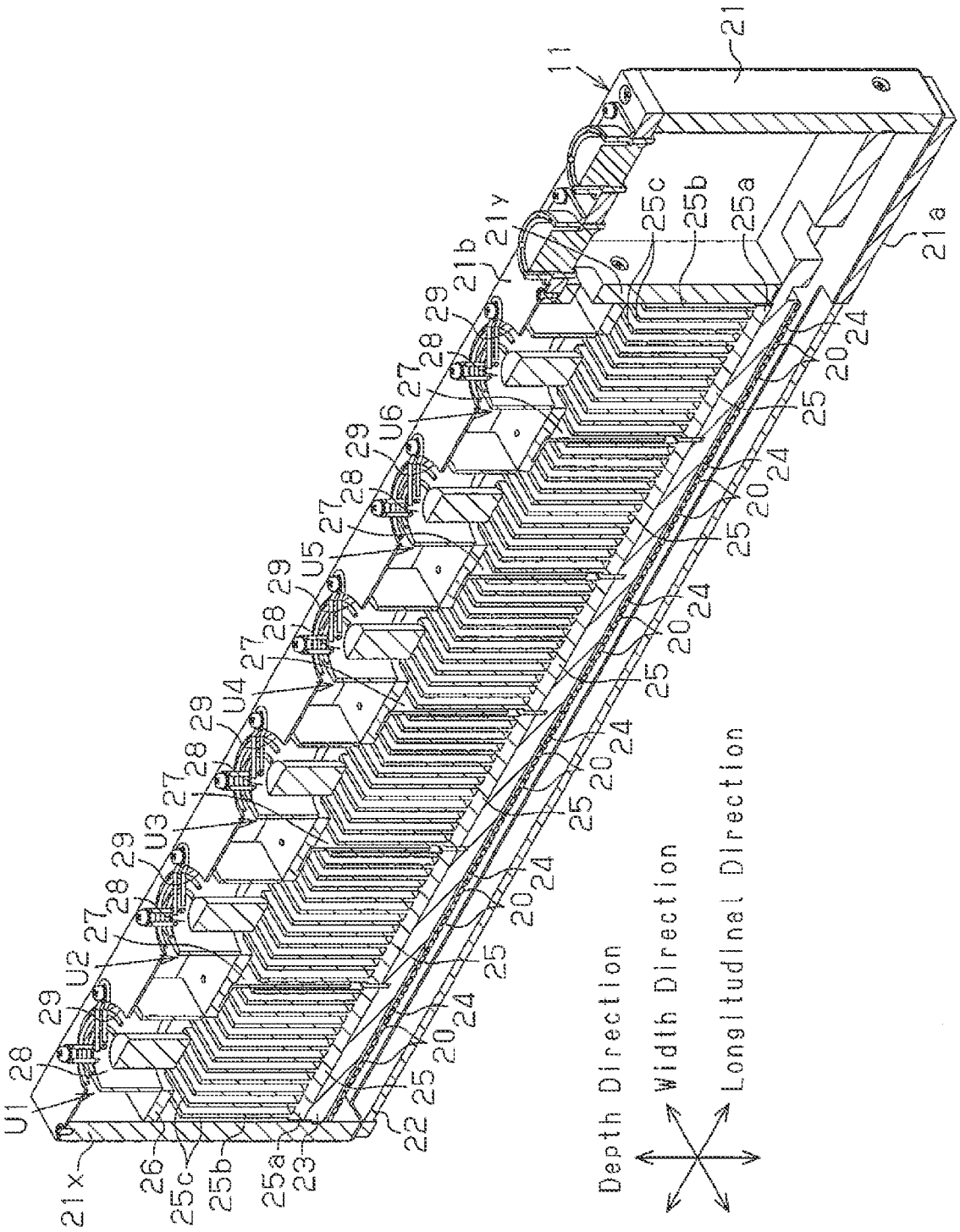
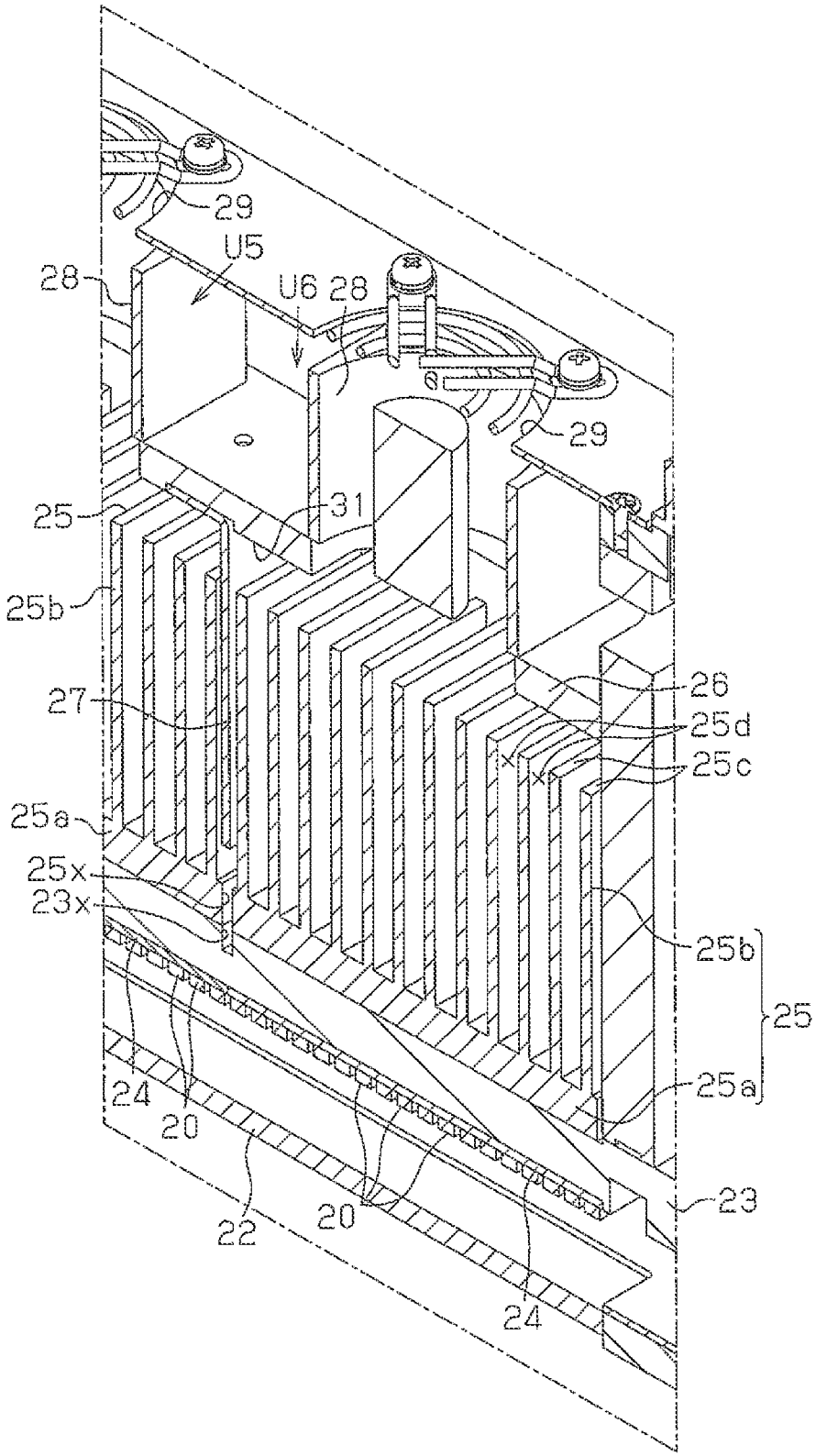

11
21
21y
21b
21a
25c
25b
25a
U1
U2
U3
U4
U5
U6
21x
26
23
22
Depth Direction
Width Direction
Longitudinal Direction

Fig.2

Fig.3


29
U5
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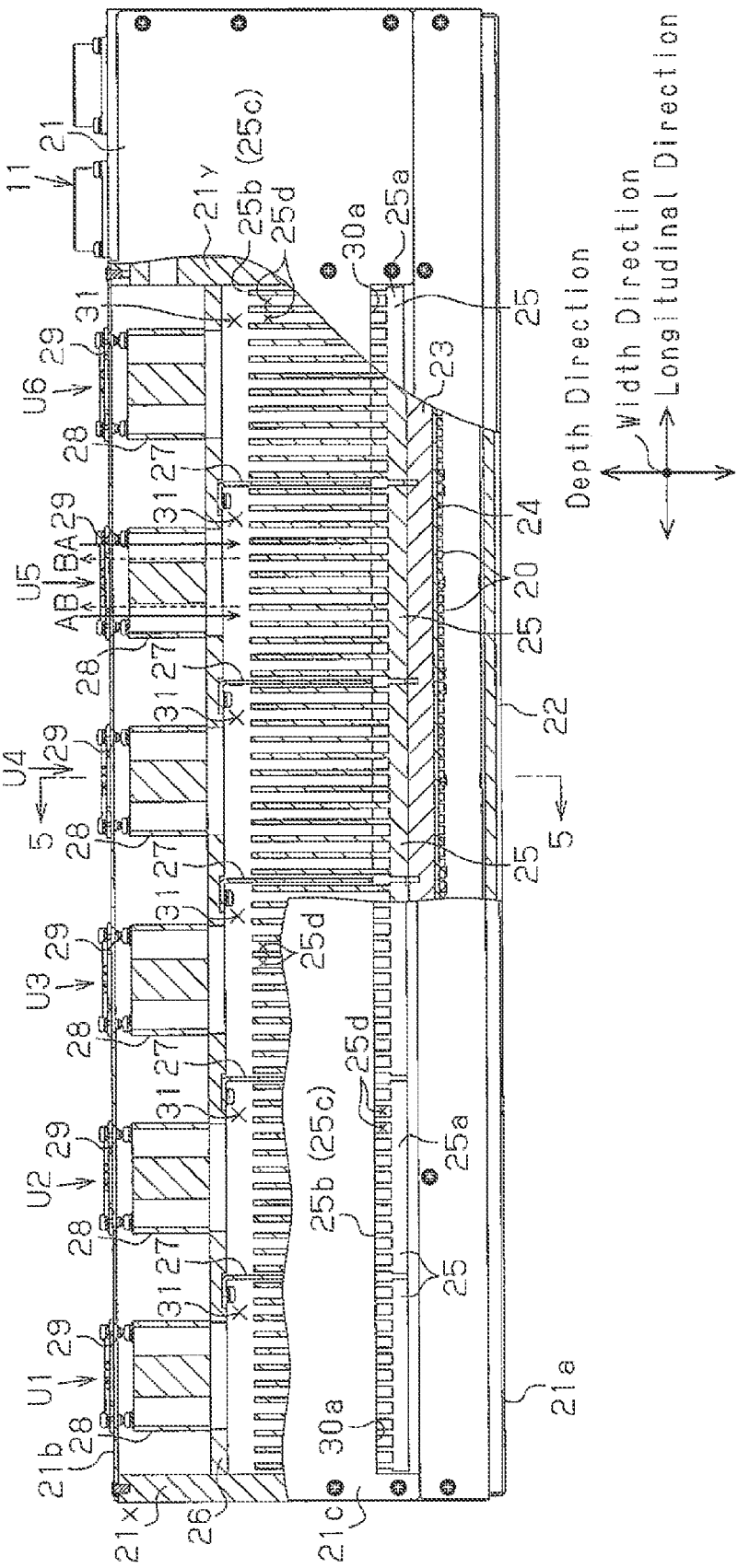
U6 28
29
25
31
25b
27
26
25d
25c
25a
25x
23x
25b
25
25a
24
20
22
20
23
24

Fig.4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21
21y
25b (25c)
25d
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24
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U5
U4
U3
U2
U1
AB
BA
5
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21b
21x
26
21c
Depth Direction
Width Direction
Longitudinal Direction

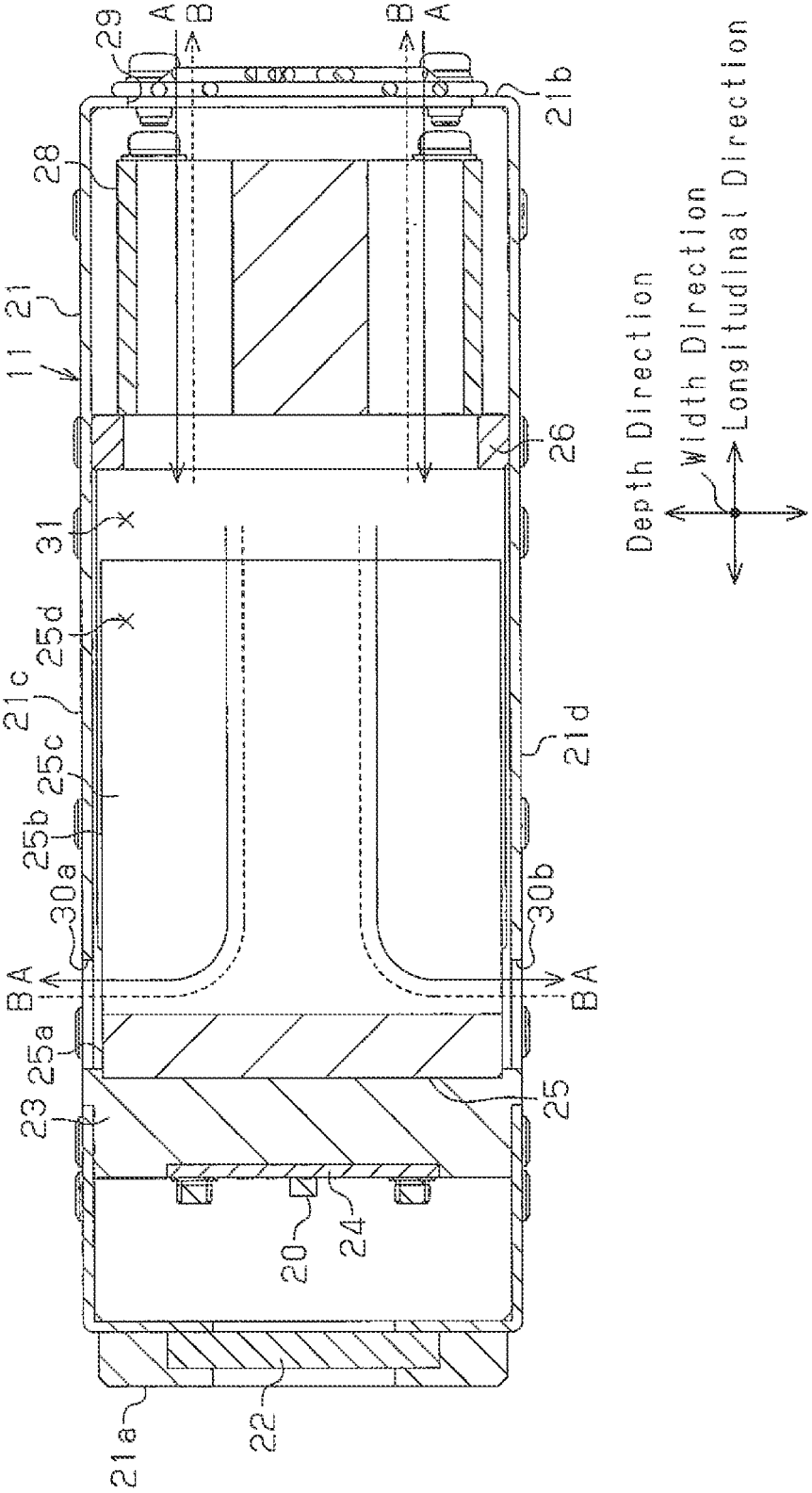
29
A
B
B
A
21b
28
11
21
26
31
25d
21c
25c
25b
30a
30b
21d
BA
BA
25a
23
25
20
24
21a
22
Depth Direction
Width Direction
Longitudinal Direction

Fig.5

ULTRAVIOLET IRRADIATION HEAD AND ULTRAVIOLET IRRADIATOR

TECHNICAL FIELD

The present invention relates to an ultraviolet irradiation head including a heat dissipation structure for an ultraviolet LED element, and an ultraviolet irradiator using the ultraviolet irradiation head.

BACKGROUND

The ultraviolet irradiator is used for irradiating an ultraviolet curable material with an ultraviolet ray and curing the material. For example, the ultraviolet irradiator includes a collection of multiple ultraviolet LED elements as a light source of an irradiation head. Change in an ambient temperature caused by heat generated by the ultraviolet LED elements changes the intensities of ultraviolet rays emitted from the ultraviolet LED elements. Thus, the ultraviolet irradiator including the collection of the LED elements is equipped with a heat dissipation structure provided together with a light source to obtain stable ultraviolet rays.

A heat dissipation structure disclosed for example in Japanese Laid-Open Patent Publication No. 2011-5788 or Japanese Laid-Open Patent Publication No. 2012-4454 includes a substrate on which LED elements are mounted, a heat sink arranged on the back surface of the substrate, and a fan unit that supplies cooling air to a fin of the heat sink. The heat sink and the fan unit efficiently dissipate heat from the LED elements.

However, failing to uniformly dissipate heat from the collection of the ultraviolet LED elements causes variation in the respective intensities of ultraviolet rays emitted from the multiple ultraviolet LED elements. In the case of a line irradiation head, for example, the respective intensities of ultraviolet rays from the multiple ultraviolet LED elements vary in a direction in which the LED elements are aligned in a linear pattern. This makes the curing condition of an ultraviolet curable material vary in the direction in which the ultraviolet LED elements are aligned.

SUMMARY

It is an object of the present invention to provide an ultraviolet irradiation head capable of dissipating heat from multiple ultraviolet LED elements uniformly and making the intensities of ultraviolet rays emitted from the LED elements uniform as a whole and an ultraviolet irradiator using the ultraviolet irradiation head.

In order to achieve the aforementioned object, a first aspect of the present invention provides an ultraviolet irradiation head including a substrate, multiple ultraviolet LED elements arranged on the substrate, a heat sink thermally connected to the substrate, and a fan unit. The heat sink includes a fin segment formed of multiple fins aligned in a direction in which the ultraviolet LED elements are aligned. Cooling air traveling from the fan unit acts on the fin segment to cool the ultraviolet LED elements. The fan unit is arranged near a distal end of the fin segment. A vent hole is formed in a case of the irradiation head. The vent hole is formed so as to expose a base end of the fin segment entirely in the direction in which the fins are aligned. The heat sink is configured such that each gap between the fins is substantially blocked in a part other than where the vent hole is present. The gap is an opening extending in a width direction perpendicular to the direction in which the fins are aligned. Space between the distal end of the fin segment and the fan unit functions as a pressure chamber, which is placed in a positively pressurized condition or a negatively pressurized condition by the air flow from the cooling fan unit.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of an irradiation head in an ultraviolet irradiator of an embodiment of the present invention;

FIG. **2** is a sectional perspective view of the irradiation head;

FIG. **3** is a sectional perspective view showing a part of the irradiation head in an enlarged manner;

FIG. **4** is a vertical sectional view of the irradiation head; and

FIG. **5** is a sectional view taken along line **5-5** of FIG. **4**.

DETAILED DESCRIPTION

An embodiment that embodies an ultraviolet irradiator (ultraviolet irradiation head) of the present invention is described below by referring to FIGS. **1** to **5**. For the description of the ultraviolet irradiator, a width direction, a depth direction, and a longitudinal direction are defined as shown in FIGS. **1**, **2**, **4**, and **5**.

As shown in FIG. **1**, an ultraviolet irradiator **10** includes an ultraviolet irradiation head (hereinafter called an irradiation head) **11** and a controller **12**. The ultraviolet irradiator **10** emits an ultraviolet ray from a light source of the irradiation head **11** for curing an ultraviolet curable material.

As shown in FIGS. **1** to **5**, the irradiation head **11** is a line irradiation head formed of multiple ultraviolet LED elements (hereinafter called LED elements) as a light source arranged in a linear pattern. More specifically, the irradiation head **11** includes a case **21** in the form of a rectangular box. The case **21** extends in the direction in which the LED elements **20** are aligned. The case **21** has six outer side surfaces including a front surface **21***a* and a back surface **21***b*. The front and back surfaces **21***a* and **21***b* are each formed of the longest side and the shortest side. A window member **22** is fitted to the front surface **21***a* so as to hermetically close the LED elements **20**. The window member **22** allows ultraviolet rays emitted from the LED elements **20** to pass therethrough. The window member **22** has a rectangular shape extending in a way corresponding to a row of the LED elements **20**. The longitudinal direction of the irradiation head **11** agrees with the direction in which the LED elements **20** are aligned.

A base plate **23** is arranged behind the window member **22**. Like the window member **22**, the base plate **23** has a rectangular shape. The base plate **23** is fixed to the case **21**. The base plate **23** is made of metal. A surface of the base plate **23** facing the window member **22** is provided with six substrates **24** on which the LED elements **20** are mounted. Each substrate **24** has a rectangular shape and is arranged such that the long axis of the substrate **24** is pointed to the longitudinal direction of the base plate **23**. All the substrates **24** are fixed to the base plate **23** while being aligned in the longitudinal direction of the base plate **23**. Eighteen LED elements **20** are attached to each substrate **24**. The LED elements **20** are aligned in a linear pattern and are spaced uniformly. Thus, the aforementioned arrangement of the six substrates **24** relative to the base plate **23** forms a long row of the LED elements **20**. The row of the LED elements **20** is arranged to face the window member **22**. Thus, ultraviolet rays emitted from the LED elements **20** pass through the window member **22** to exit out of the ultraviolet irradiator **10**.

The inside of the irradiation head **11** is formed of six units U**1** to U**6**. Each of the units U**1** to U**6** includes one substrate **24** on which the LED elements **20** are mounted, one heat sink **25**, and one fan unit **28** that are common to the units U**1** to U**6**. In the longitudinal direction of the case **21**, the six substrates **24** are aligned, the six heat sinks **25** are aligned, and the six fan units **28** are aligned. The substrates **24**, the heat sinks **25**, and the fan units **28** are housed in the case **21**. The number of the units can be changed between one to five or seven or more according to the specifications of the irradiation head **11**. The base plate **23** or the case **21** can be changed in length according to the number of the units.

The heat sink **25** is fixed to a surface of the base plate **23** on the opposite side of the substrate **24**. The heat sink **25** is made of a metallic material having high heat dissipation performance. The heat sink **25** is thermally connected to the base plate **23** by abutting contact therebetween. This efficiently transfers heat generated by the LED elements **20** to the heat sink **25** via the base plate **23**. Like the substrates **24**, the six heat sinks **25** are housed in the irradiation head **11**. The heat sinks **25** are aligned in the longitudinal direction of the base plate **23**.

The heat sink **25** includes a base segment **25***a* and a fin segment **25***b*. The base segment **25***a* has a rectangular shape and has an area substantially the same as that of the substrate **24**. The widest surface of the base segment **25***a* forms surface contact with the base plate **23**. A surface of the base segment **25***a* on the opposite side of the base plate **23** is provided with the fin segment **25***b* formed of multiple fins **25***c*. The fins **25***c* are formed of rectangular thin plates extending in the width and depth directions of the irradiation head **11**. The number of the fins **25***c* is the same as or larger than the number of the LED elements **20**. To avoid complexity, only **12** fins **25***c* are shown in each drawing. All the fins **25***c* are spaced uniformly in the longitudinal direction of the base plate **23**. In other words, the fin segment **25***b* has a rectangular shape as viewed in the longitudinal direction and a comb-like shape as viewed in the width direction. The case **21** has a side surface **21***c* and a side surface **21***d* in a pair facing each other in the width direction of the irradiation head **11**. As shown in FIG. **5**, the fin segment **25***b* and the base segment **25***a* are near the side surfaces **21***c* and **21***d* of the case **21** and substantially abut on the side surfaces **21***c* and **21***d*.

A base plate **26** is arranged near a distal end of the fin segment **25***b*. The base plate **26** is spaced by a given distance from the distal end of the fin segment **25***b*. The base plate **26** is fixed to the case **21**.

Five partition plates **27** are fixed to the base plate **26** for partitioning between adjacent ones of the units U**1** to U**6** and adjacent ones of the heat sinks **25**. The partition plates **27** are made of rectangular thin plates extending in the width and depth directions of the irradiation head **11**. A distal end of the partition plate **27** extends as far as the base end of the fin segments **25***b* of the heat sink **25**, more specifically, to the vicinity of the base segment **25***a*. The unit U**1** in the outermost part is arranged in space defined by a side wall member **21***x* of the case **21** and the partition plate **27**. The unit U**6** on the opposite side of the unit U**1** is arranged in space defined by a side wall member **21***y* of the case **21** and the partition plate **27**. The side wall member **21***x* forms a part of the outer wall of the case **21**. The side wall member **21***y* forms a part of the inner wall of the case **21**. Each of the units U**2** to U**5** is arranged in space defined by the partition plates **27** in a pair. In addition defining the space for each of the units U**1** to U**6**, the partition plates **27** suppress transfer of heat generated in each space. Specifically, the partition plates **27** further function as a heat-insulating member.

As shown in FIG. **3**, a gap **25***x* is provided as well as the heat-insulating structure including the partition plate **27** between the base segments **25***a* of adjacent ones of the heat sinks **25**. The base plate **23** is provided with a groove part **23***x* continuous with the gap **25***x*. The gap **25***x* and the groove part **23***x* suppress transfer of heat generated in the units U**1** to U**6** together with the partition plate **27**. While the irradiation head **11** is in use, all the LED elements **20** in the units U**1** to U**6** may be turned on or some of the LED elements **20** in the units U**1** to U**6** may be turned on. Heat insulation by the heat-insulating structure including the partition plate **27**, the gap **25***x*, and the groove part **23***x* is to be more responsive to a large temperature difference to occur if some of the LED elements **20** in the units U**1** to U**6** are turned on than a small temperature difference to occur between adjacent units if all the LED elements **20** in the units U**1** to U**6** are turned on. As an example of the former case, a large temperature difference may occur between the adjacent units U**4** and U**5** if the LED elements **20** in the units U**1** to U**4** are turned on while the LED elements **20** in the units U**5** and U**6** are turned off.

The six fan units **28** are installed on the base plate **26**. One fan unit **28** is provided to each of the units U**1** to U**6**. The fan unit **28** makes a motor rotate a fan, thereby generating cooling air. The fan unit **28** starts running simultaneously with turn-on of the LED elements **20**. The fan unit **28** stops running simultaneously with turn-off of the LED elements **20**.

Six vent holes **29** are formed in the back surface **21***b* of the case **21**. Each of the vent holes **29** is arranged to face a corresponding fan unit **28**. As shown in FIG. **5**, a vent hole **30***a* and a vent hole **30***b* are further formed in the side surfaces **21***c* and **21***d* of the case **21** respectively. Each of the vent holes **30***a* and **30***b* is formed to form a pair together with the vent hole **29**. The vent holes **30***a* and **30***b* are formed of long openings extending in the longitudinal direction across the all units U**1** to U**6**. Thus, the base ends of the fin segments **25***b* of all the heat sinks **25** are exposed through the vent holes **30***a* and **30***b* to the outside entirely as viewed in the longitudinal direction. As viewed in the depth direction, the base ends of the fin segments **25***b* are exposed only partially to the outside through the vent holes **30***a* and **30***b*.

A fan unit prepared as the fan unit **28** includes an intake fan unit that sucks in air through the vent hole **29** in the back surface **21***b* of the case **21** and exhausts air through the vent holes **30***a* and **30***b*, and an exhaust fan unit that exhausts air through the vent hole **29** and sucks in air through the vent holes **30***a* and **30***b*. Solid lines A with arrows of FIGS. **4** and **5** show a flow of cooling air formed by using the intake fan unit **28**. Dashed lines B with arrows of FIGS. **4** and **5** show a flow of the cooling air formed by using the exhaust fan unit **28**.

As described above, the units U**1** to U**6** are separated with the side wall members **21***x* and **21***y* and the partition plates **27**. Space functioning as a pressure chamber **31** is formed between the distal end of the fin segment **25***b* of the heat sink **25** and the base plate **26**.

The space in the pressure chamber **31** defined by the side wall member **21***x* or **21***y* and the partition plate **27** or by the partition plates **27** has a cross-sectional area same as that of corresponding space in the fin segment **25***b*. Meanwhile, a flow path area of cooling air formed by the fan unit **28** is smaller in the fin segment **25***b* by the presence of the fins **25***c* than in the pressure chamber **31**. A flow path area in the fin segment **25***b* is determined by the sum of gaps **25***d* between all the fins **25***c* of this fin segment **25***b*. The fin segment **25***b* substantially abuts on the side surfaces **21***c* and **21***d* of the case **21** in the width direction. Thus, each gap **25***d* between the fins **25***c* is substantially blocked in a part except where the

vent holes **30***a* and **30***b* are present. Where the sum of the areas of the vent holes **30***a* and **30***b* is defined as S**1** and the sum of the areas of the gaps **25***d* between the distal ends of all the fins **25***c* is defined as S**2**, S**1** and S**2** satisfy S**1**<S**2**.

As understood from above, the cooling air passes through the gaps **25***d* between the fins **25***c* where the flow path of the cooling air is narrowed. The intake fan unit **28** places the pressure chamber **31** in a positively pressurized condition. The exhaust fan unit **28** places the pressure chamber **31** in a negatively pressurized condition. The flow of the cooling air is likely to be deflected in response to the rotation of the fan unit **28**. Meanwhile, placing the pressure chamber **31** between the fan unit **28** and the fin segment **25***b* of the heat sink **25** in a positively or negatively pressurized condition makes deflection unlikely to occur in the flow of the cooling air. As a result, in the fin segment **25***b*, the cooling air acts uniformly on the gaps **25***d* between the multiple fins **25***c*.

The irradiation head **11** is connected to the controller **12**. The controller **12** controls turn-on of the LED elements **20** and running of the fan unit **28**. The irradiation head **11** is used in a manufacturing line where ultraviolet curable materials applied to products are cured, for example. A range of turn-on of the LED elements **20** can be changed by the units U**1** to U**6** in advance or as occasion arises.

The action of the heat dissipation structure of the irradiation head **11** is described next.

In the irradiation head **11**, the positions of the fan unit **28** and the vent holes **29**, **30***a* and **30***b* in the case **21** relative to each other determine the flow of the cooling air as follows. In the case of the intake fan unit **28**, the cooling air passes through the vent hole **29**, the fan unit **28** and the pressure chamber **31** in this order. Next, the cooling air travels from each gap **25***d* between the distal ends of the fins **25***c* toward the base end of each fin **25***c* and is then discharged through the vent holes **30***a* and **30***b* out of the irradiation head **11**. In the case of the exhaust fan unit **28**, the cooling air flows in through the vent holes **30***a* and **30***b*. Next, the cooling air travels from each gap **25***d* between the base ends of the fins **25***c* toward the distal ends of each fin **25***c*. Then, the cooing air passes through the pressure chamber **31**, the fan unit **28**, and the vent hole **29** in this order. In this case, the cooling air extends through each gap **25***d* between the fins **25***c* of the fin segment **25***b* sufficiently. Specifically, the cooling air extends from the distal end to reach the base end of each fin **25***c*, so that the cooling air acts on substantially all of the fin segment **25***b*.

The presence of the pressure chamber **31** distributes the cooling air uniformly in the direction in which the fins **25***c* are aligned and the width direction. This allows the cooling air to easily go into the gaps **25***d* between all the fins **25***c* extending from the central part toward the end part of the fin segment **25***b*. Thus, the heat sink **25** dissipates heat uniformly from the entire fin segment **25***b*. The fins **25***c* of the heat sink **25** are aligned in the same direction in which the LED elements **20** are aligned. Thus, all the LED elements **20** are cooled uniformly.

In some cases, some vent holes different from the vent holes **30***a* and **30***b* may be formed in the outer surface of the case **21**. This weakens the function of the pressure chamber **31**, so that the cooling wind acts in a way differing between the central part and the end part of the fin segment **25***b*. This narrows a part of the gap **25***d* between the fins **25***c* functioning as a flow path, so that the cooling air does not extend sufficiently through the gap **25***d* between the fins **25***c*. Further, in this embodiment, the fin segment **25***b* entirely faces the pressure chamber **31**. In contrast, if the pressure chamber **31** is smaller than the fin segment **25***b*, heat dissipation performance achieved by a part of the fin segment **25***b* may become lower than that achieved by the remaining part of the fin segment **25***b*. As an example of this case, a wall may exist between a part of the fin segment **25***b* and the pressure chamber **31**. In this case, heat dissipation by the heat sink **25** varies partially, making it impossible to uniformly cool the LED elements **20** in alignment.

In contrast, the heat dissipation structure of this embodiment can uniformly cool the LED elements **20** in alignment. This can control variation in the respective intensities of ultraviolet rays emitted from the LED elements **20** at a low level. As a result, an entire ultraviolet curable material applied in a linear pattern can be cured uniformly.

Thus, the present invention achieves the following effects.

(1) The fan unit **28** is arranged near the distal end of the fin segment **25***b* of the heat sink **25** thermally connected to the substrate **24** on which the LED elements **20** are mounted. The vent holes **30***a* and **30***b* are formed in the case **21**. The base end of the fin segment **25***b* of the heat sink **25** is exposed through the vent holes **30***a* and **30***b* to the outside entirely as viewed in the direction in which the fins **25***c* are aligned. In the width direction perpendicular to the direction in which the fins **25***c* are aligned, each gap **25***d* between the fins **25***c* is substantially blocked by the case **21** in a part except where the vent holes **30***a* and **30***b* are present. Specifically, each gap **25***d* between the multiple fins **25***c* forming the fin segment **25***b* can function as a flow path through which the cooling air from the fan unit **28** passes. The space between the distal end of the fin segment **25***b* and the fan unit **28** functions as the pressure chamber **31**. The cooling air from the fan unit **28** places the pressure chamber **31** in a positively or negatively pressurized condition. The pressure chamber **31** makes deflection unlikely to occur in the flow of the cooling air, so that the cooling air acts uniformly on the entire fin segment **25***b*. As a result, the heat sink **25** can cool the LED elements **20** uniformly mounted on the substrate **24**. This can make the intensities of ultraviolet rays emitted from the LED elements **20** uniform.

(2) The irradiation head **11** houses the units U**1** to U**6** in alignment. The units U**1** to U**6** are each formed of the substrate **24** on which the LED elements **20** are mounted, the heat sink **25**, and the fan unit **28**. The partition plate **27**, the gap **25***x* between the base segments **25***a* of adjacent ones of the heat sinks **25**, and the groove part **23***x* in the base plate **23** are formed between adjacent ones of the units U**1** to U**6**. The partition plate **27**, the gap **25***x* and the groove part **23***x* function as insulation to suppress the transfer of heat between the units U**1** to U**6**. If a range of turn-on of the units U**1** to U**6** is changed according to the size of a target of irradiation, for example, a large difference is generated between a temperature inside a unit being turned on and a temperature inside a unit being turned off. This temperature difference particularly affects the heat sink **25** and the substrate **24** arranged near a boundary between the unit being turned on and the unit being turned off, and the intensities of ultraviolet rays from the LED elements **20**. In this case, the intensities of ultraviolet rays from the LED elements **20** do not become uniform as a whole. In this regard, in this embodiment, the heat-insulating structure is provided in the boundary between adjacent ones of the units U**1** to U**6**. This makes variation unlikely to occur in the intensities of ultraviolet rays from LED elements in the unit being turned on adjacent to the unit being turned off.

The aforementioned embodiment can be changed as follows.

The LED elements **20** may be arranged in rows.

The vent holes **30***a* and **30***b* are each an opening extending in the longitudinal direction. Alternatively, each of the vent hole **30***a* and **30***b* may be multiple openings. In this case, it is

preferable that each of the vent holes **30***a* and **30***b* be formed so as to expose the gap **25***d* at least between the base ends of the fins **25***c*.

The base plate **23** arranged between the substrate **24** on which the LED elements **20** are mounted and the heat sink **25** may be omitted. In this case, the substrate **24** and the heat sink **25** may be thermally connected by forming direct abutting contact therebetween. Alternatively, a heat-conducting member may be arranged between the substrate **24** and the heat sink **25**.

The partition plate **27** may be fixed to a member other than the base plate **26**. As an example, the partition plate **27** may be fixed to the case **21**.

The heat-insulating structure including the gap **25***x* between the base segments **25***a* of the heat sink **25** and the groove part **23***x* in the base plate **23** to achieve air heat insulation may be replaced by a heat-insulating structure formed by using a material of high heat-insulating performance.

In the fin segment **25***b* of the heat sink **25**, the gap **25***d* as an opening extending in the width direction is substantially blocked by the case **21**. Alternatively, the gap **25***d* may be blocked by a member other than the case **21**.

The irradiation head **11** may be formed of one to five units or seven or more units.

We claim:

1. An ultraviolet irradiation head comprising

a substrate,

multiple ultraviolet LED elements arranged on the substrate,

a heat sink thermally connected to the substrate, and

a fan unit,

the heat sink including a fin segment formed of multiple fins aligned in a direction in which the ultraviolet LED elements are aligned, and wherein in operation, cooling air travels from the fan unit and acts on the fin segment to cool the ultraviolet LED elements, wherein the fan unit is arranged near a distal end of the fin segment,

a vent hole is formed in a case of the irradiation head, and the vent hole is formed to expose a base end of the fin segment entirely in the direction in which the fins are aligned, wherein the vent hole is formed over gaps between all of the fins,

and wherein a flow path area of the cooling air flowing through the vent hole is less than a flow path area of the cooling air flowing through the gaps between all of the fins,

the heat sink is configured such that each gap between the fins is substantially blocked in a part other than where the vent hole is present,

the gap is an opening extending in a width direction perpendicular to the direction in which the fins are aligned, and

space between the distal end of the fin segment and the fan unit functions as a pressure chamber that is placed in a positively pressurized condition or a negatively pressurized condition by the cooling air from the fan unit.

2. The ultraviolet irradiation head according to claim **1**, comprising:

multiple units arranged in the direction in which the LED elements are aligned, wherein the units each include the substrate on which the ultraviolet LED elements are mounted, the heat sink, and the fan unit; and

insulation that suppresses transfer of heat between adjacent ones of the units.

3. An ultraviolet irradiator comprising:

the ultraviolet irradiation head according to claim **1**; and

a controller that controls the ultraviolet irradiation head,

wherein the control of the ultraviolet irradiation head includes control of activation of the ultraviolet LED elements and control of running of the fan unit.

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